NOTES ON THE SEASONAL OCCURRENCE OF RANGOON EARTHWORMS.

BY

G. E. GATES,

Biology Department, Judson College, Rangoon, Burma.

Casual study several years ago of collections of Rangoon earth worms seemed to show wide variations in the numbers of species to be found at different seasons of the year in this city. In order to obtain further information on this subject a record was kept of species, date of finding, and locality of all worms brought into the laboratory during the school year of 1923–1924. While these records confirmed the earlier ideas as to the seasonal occurrence they gave no information as to the relative rarity of the various species in the seasons in which they occur. Furthermore the collections were not made systematically so that the tabulation of the results left much to be desired in the way of completeness. In order to overcome these defects and to obtain additional information a slightly different procedure was adopted and put into practice during the last school year, (1924–1925). In the middle of every month one of the college *mahlis* was sent out each morning for several days in succession to dig for worms in widely separated regions of the town. The *mahli* was provided with a bicycle to enable him to cover the area in the time allotted and ordered to dig in as many different kinds of situations as could be found, such as sandy, loamy, clayey soil; in gardens, ditches, bogs, compost heaps, garbage piles, rice fields, jungle, etc. The worms brought into the laboratory at the end of the day's work were sorted according to species and counted. At the end of the week the daily totals were added to secure a monthly grand total. These monthly totals are given below in Table B.

In the rainy months the earth worms were easily secured in almost any soil, although numerous attempts to obtain these worms from the clayey paddy fields, either before or after the water was drained off, were without success. At the close of the rainy season the soil slowly dried, in many places becoming very hard and cracked. As the season progressed the worms could, of course, only be found in places that remained wet due to some accident of location. The search was then confined to ground near tanks, lakes, and wells, to ditches, swamps, river banks, and soil that received drainage water from bathrooms and cookhouses, etc.

At first the collecting was directly supervised by the writer but limitations of time made it impossible to continue this direct supervision every month. It is therefore impossible to guarantee that all types of localities were visited every month. The tabulation of the results of the collecting seems to show however that the work was faithfully done. Thus *Perionyx excavatus* and *P. fulvus*, for instance, are usually not found with other worms but in soil rich in putrefying matter. The former was obtained every month and the latter in nine months. To secure these specimens visits must have been paid to the particular type of situation in which the species are usually found.

The geology of Rangoon.—The soil of Rangoon and immediate vicinity is mostly river alluvium—sands, clays, etc., with patches of old tertiary sands which have been partly changed into laterite. The weathered laterite forms reddish soil rich in iron. The altitude is roughly speaking a little above sea level.

The seasons.—The year may be divided into two seasons in Rangoon according to the rainfall; the rainy reason (May to October) comprising roughly the months in which there are from ten to thirty rainy days and a fall of five or more inches of rain per month, and the dry season (November to April) in which there are usually less than five rainy days and a rainfall of much less than five inches per month. The dry season may be subdivided according to temperature. The months of November to February inclusive in which the mean temperature is usually below 80 are referred to locally as the cold season or cold weather. Similarly the period including the months of March, April, and May, in which the mean temperature is usually above 80 is referred to as the hot season.

In order to show as concisely as possible conditions in this city as to rainfall, rainy days, temperature and humidity, throughout the year, the results of meteorological observations made at the Imperial Observatory in Rangoon town have been secured from the monthly tables published in the Supplement to *The Burma Gazette*. These figures constitute Table A.

TABLE A

No.	——	1924								1925				
		May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1	Actual rainfall in inches.	9·54	18·58	26·02	28·31	16·92	13·07	1·23	...	...	...	...	4·59	14·95
2	Normal rainfall in inches.	11·98	18·04	21·42	19·87	15·27	6·91	2·79	0·37	0·21	0·22	0·32	1·63	11·98
3	Actual number of rainy days.	15	23	27	27	19	15	5	...	...	...	...	A.	A.
4	Normal number of rainy days.	13·6	23	25·1	24·1	19·7	10	3·3	0·6	0·3	0·3	0·6	1·7	13·6
5	Mean relative humidity.	84%	89%	92%	93%	89%	87%	83%	80%	76%	83%	85%	82%	84%
6	Mean temperature.	85·2	81·5	79·9	80·6	82	82	81·6	76·2	76·9	78·8	83·7	83·6	84

A.—Information not obtainable.

TABLE B

Number.				1924								1925				
				May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
1	Drawida	longatria	E	+	2	...	2	...	..	1	...	16	177	85	×	22
2	,,	peguana	E	+	3	2	37	1	3	7	2	12	...	...	×	4
3	,,	rangoonensis ...	E	...	...	..	...	...	...	...	...	...	...	...	×	...
4	,,	rara	E	...	...	...	...	...	...	...	...	...	...	...	×	...
5	Megascolex	mauritii. (NR) ...	P	+	5	...	3	...	4	2	...	14	12	225	×	93
6	Pheretima	anomala	E (?)	...	2	4	28	17	25	3	4	...	...	...	×	...
7	,,	elongata. (NB) ...	P	...	11	...	...	...	...	4	...	...	...	...	×	...
8	,,	houlleti	P	+	3	14	38	22	18	49	3	...	7	2	×	...
9	,,	insolita	E	...	...	...	149	12	105	2	4	...	...	...	×	...
10	,,	lignicola	P	...	...	7	20	6	4	2	...	..	...	...	×	...
11	,,	peguana	P	I (?)	80	201	394	127	196	212	...	...	...	...	×	24
12	,,	planata	E	...	...	...	...	8	...	...	...	...	...	...	×	...
13	,,	posthuma. (NR) ...	P	+	11	8	58	18	113	55	15	51	37	47	×	34
14	Perionyx	excavatus	P	+	2	4	91	18	24	2	3	75	18	22	×	45
15	,,	fulvus. (NR) ...	P	+	3	14	4	3	1	3	...	...	2	4	×	6
16	Octochætus	birmanicus	E	+	14	7	98	9	63	29	40	228	439	187	×	4
17	Eutyphoeus	foveatus	E	...	140	169	260	22	54	...	...	...	...	...	×	189
18	,,	peguanus	E	...	...	4	27	12	44	2	...	...	...	...	×	...
19	,,	rarus	E	...	...	...	...	4	...	...	...	...	...	...	×	...
20	Pontoscolex	corethrurus. (NB) ...	P	+	3	11	82	3	2	24	14	130	134	153	×	8
21	Glyphidrilus	papillataus. (NR) ...	P	...	...	...	...	...	...	...	...	...	...	209	×	...

E.—endemic.
E ?—probably endemic. [See Gates (2).]
P.—peregrine.

\+ worms of the species indicated secured but not counted.
. . . . worms of the species indicated not secured.
I ?—immature forms probably of the species indicated.

NR.—Not previously reported from Rangoon but reported from elsewhere in Burma.
NB.—not previously reported from Burma proper.
X.—No collections made. No collecting has yet been done in the vacation month of April. The normal amount of rainfall in this month is too small to bring out the hibernating forms and the ground around wells, etc., remains as moist as in March It is therefore probable that the same species occur in April as in March. At least those species which have been found to occur in both March and May will doubtless be found in April.

Discussion.—Study of Table B shows that the worms of Rangoon may be arranged into three groups according to their seasonal occurrence. In the first group are those forms which have been found only in the rainy season or which are practically limited to the rainy months, disappearing as the soil dries in November and December, not to be found again until the rains are under way in the next season. This group contains the following species :—

Pheretima anomala
,, *insolita*
,, *lignicola*
,, *peguana*
,, *planata*
Eutyphœus foveatus
,, *peguanus*
,, *rarus.*

Of this group of eight species, six are endemic in Burma, and the other two although peregrine are limited in their distribution. *P. lignicola* has not hitherto been reported outside of India and Burma. *P. peguana* is apparently confined to a region including Burma, Siam, and the islands to the south of the Malay Peninsula.

The second group contains those species which occur throughout the year or which have been found in both the rainy and dry months. The year-round species are :—

Pheretima posthuma
Perionyx excavatus
,, *fulvus*
Octochaetus birmanicus
Pontoscolex corethrurus.

Records of previous years together with the records for 1924-25 permit the inclusion of the following species in this section of the group :—

Drawida longatria
Megascolex mauritii
Pheretima houlleti.

The second section of this group is composed of the following species which have been found in both rainy and dry season months although not yet known to occur in every month of the year :—

Drawida peguana
Pheretima elongata.

The first of these two species have already been found in nine months of the year. *P. elongata* is very rare and only seventeen specimens have been found hitherto in Rangoon, eleven in June 1924, four in November 1924, and two in January 1923.

Of this second group only three species, *D. longatria*, *D. peguana*, and *O. birmanicus* are endemic. All the rest of this group with the possible exception of *Perionyx fulvus* are widely distributed.

The third group is composed of the following species which have been found up to the present time only in the dry season months and not in the rainy months :—

Drawida rangoonensis
,, *rara.*
Glyphidrilus papillatus

It should not be understood to mean that the forms of this group are considered to be limited in occurrence to the dry season, but only that they have not yet been found in any other season. The two species of *Drawida* are very rare in Rangoon. *D. rangoonensis* was found in November 1923, and in spite of repeated searches in the same and similar localities has not been obtained again. *D. rara* was described from six specimens obtained in November and December 1923. No further specimens have been secured. *G. papillatus* was found as the result of a chance search in still slightly moist soil at the bottom of a depression that had been covered with water for the previous ten months, during a great deal of which time the water was two feet or more deep. This species may be secured in Kalaw in March, April, and May, in Bhamo in March, in both places in soil that is slightly submerged.

Possibly in similar situations in Rangoon these worms may be found all the year round. Collections have been made nearly every month in the ground near the depression mentioned above but without securing any specimens. It is hoped that further studies now in progress will furnish additional information regarding the occurrence of these three forms.

Variation from normal amount of rainfall as related to variation in occurrence of earthworms.—In the course of this study there have seemed to be several cases in which marked variations from the normal amount of rainfall have coincided with variations in the occurrence of certain earthworms. It has not been possible hitherto to check carefully these cases. The completion of the first year's work under the method described in the first paragraph of this paper has furnished a means for checking such variations. In order to show one such coincidence the month of May 1925 has been included in both tables to enable comparison with the same month of 1924. In May 1924 there was 9·54 inches of rainfall. In the same month of 1925 there was a rainfall of 14·95 inches, or nearly three inches more than normal. In May 1924 with nearly two and one half inches less than normal the only rainy season worms obtainable were probably immature specimens of *P. peguana*. In May 1925 with 5·41 more inches of rain than in the same month of the previous year *P. peguana*, and *E. foveatus*, both rainy season forms, were readily obtainable in numbers in exactly the same situations which had yielded the year before only year-round species and immature forms.

Apparently, then, a difference of a fairly small number of inches (when compared to the total amount of rainfall) especially at the beginning of the season may make quite a difference in the worms to be found at that time. This is rather strikingly illustrated by a collecting experience at Meiktila. This town is within the so-called dry belt of Burma and has a yearly average of 52·8 rainy days with only about thirty-three inches of rain. The first collection was made there on May 20, at which time there had been no rain for months. The ground was dry and hard and only a very few specimens were secured, most of which were found in an irrigated garden. The earth around wells and tanks, in which there is almost always a fair number of worms, even in the driest months, furnished at this place only two or three specimens. The worms obtained were *M. mauritii* and *P. posthuma*, both peregrine forms. There were light showers on the next day (May 21) and every day thereafter for several weeks there was more or less rain. On 24th no more worms were to be obtained than on the first day of collecting. The next few days were spent in collecting elsewhere. On returning to Meiktila on the 28th castings were found scattered everywhere and worms belonging to the genus *Eutyphoeus* were obtainable in large numbers. These were mostly immature and probably endemic.

The earthworms may disappear from a locality as quickly as they appear. While collecting in Insein one day in the middle of October, *P. anomala* was found in moist ground underneath a pile of paddy husks at the rear of a small mill. Returning several days later, not a worm was to be found although to all appearances the ground under the paddy husks was as damp as at the time of the first visit.

Seasonal variations.—Specimens of *D. longatria* and *O. birmanicus* vary in size according to the season, being much longer and thicker in the wet season than in the dry season. In the rainy months *O. birmanicus* may be found up to 117 mm. in length, and 6 mm. in width, while the same species in the winter months does not measure more than 65 mm. in length and 4 mm. in diameter. Similarly *D. longatria* secured the rainy weather may measure up to 153 mm. in length, and 6 mm. in width, while specimens of the same species do not measure in the cold months more than 90 mm. in length and 4 mm. in diameter.

Breeding season.—Cocoons have been secured in every month of the year but always from places where there are several species of worms so that it has been impossible to tell to which species they belong. When worms were separated according to species and kept in the laboratory cocoon formation nearly always ceased. The one exception to this statement was *P. corethrurus* which formed cocoons in great numbers; under laboratory conditions from December to March, inclusive. These worms were found in December forming cocoons in very dry, hard soil under the shade of a big tree, betwen three to six inches below the surface.

Notes on Distribution.—All worms obtained by digging have been obtained within a depth of two feet from the surface.

Eutyphœus foveatus is found in large numbers crawling over the ground after a storm. The numbers crawling around seem to be about the same after a driving rain as milder but longer continued downfall. Only one other species of the Rangoon worms has been observed to do this, *E. peguanus*. Worms secured in this way are not included in Table B, which enumerates only those obtained by digging.

Perionyx excavatus is found in large numbers in dung heaps, in soil saturated with water from bathrooms, cookhouses, or the kitchens of native houses, or soapy water in the dhobie compounds. *P. fulvus* is often found in association with *P. excavatus*, or in similar situations. In addition to specimens obtained by digging this worm has been found in a number of other situations such as ; under the bark of fallen trees, in cavities filled with humus and water in crotches of living trees, under epiphytic ferns, in the sheathing bases of plantain leaves, under detritus accumulated on roofs, in dirt filling the cracks between the floor boards of a second story verandah of a European house.

P. insolita, *D. longatria*, and to a lesser extent *M. mauritii* and *P. anomala* occur in limited localities. These ' pockets,' discovered by accident in some cases, were ' worked intensively ' to provide material for other investigations. Due to this the numbers of *P. anomala* and *P. insolita* are unusually high in August and October. In such pockets there is usually one predominant species. Others may be absent or, if present, in much smaller numbers. *P. insolita* and *P. anomala* generally are found together. *P. anomala* may be found without *P. insolita* but the latter has not yet been found in a situation where there are none of the former.

Where do the rainy season earthworms go during the dry weather? The only answer to this question would seem to be deeper down into the ground. Bourne records finding *D. grandis* in South India in May only at a depth of nine to ten feet. In hope of obtaining some information on this matter numerous visits were made to several areas where the Rangoon Development Trust was at work. Although the excavations were in some cases deeper than ten feet no information or specimens were secured. In this connection it may be of interest to report a conversation with an old Burman. He, as well as others, was interested in the sahib who was collecting worms and stopped to chat. In conversations which have arisen in this way the question above has frequently been asked, but usually without eliciting any answer except a statement that the worms are supposed to go deep into the soil. The old man just mentioned related that some years previous, in the course of digging a pit, he came upon, at a depth of about ten feet, a large mass of worms. He claimed that the worms were coiled up into a ball about six to ten inches in diameter.

Summary

The seasonal occurrence of twenty-one species of earthworms in Rangoon is recorded. The endemic species, with three exceptions are found only in the rainy season. The peregrine forms are found all the year round. Certain species have been found only in the dry season.

Literature

Gates, G. E., 1905. Some Notes on *Pheretima anomala*, Mich., and a related Species new to India and Burma. (2) Ann. Mag. Nat. Hist. (9) 15.

Prashad, B., 1916. The earthworms of Lahore. J., Bomb. Nat. Hist. Soc. (24).